



# 150 km AB-1 Target Altitude

“Better Safe than Sorry.”

May 3, 1996

## OUTLINE

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- Compare “Critical Scale Heights” to determine risk.
- Compare 135 km and 150 km AB-1 Target Altitudes.
- Evaluate Planned Maneuvers against Unplanned Atmosphere.
- Evaluate Additional Walkin Maneuver.
- Candidate Maneuver Sizes for Walkin.

# “Critical Scale Heights” Determine the risk

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**Table 1: Baseline Aerobraking Maneuvers**

AB-#	H <sub>o</sub> (km)	ρ <sub>o</sub> (kg/km <sup>3</sup> )	h <sub>o</sub> - h (km)	DV (m/s)	h <sub>s</sub> * (km)	Qdot (W)
2	135	2	18	0.72	4.2	0.011
3	117	20	4	0.16	2.0	0.10
4	113	40	3	0.12	2.4	0.20
Post AB-4	110	60				0.33

**Table 2: Aerobraking Maneuvers with Equal Values for h<sub>s</sub>\***

AB-#	H <sub>o</sub> (km)	ρ <sub>o</sub> (kg/km <sup>3</sup> )	h <sub>o</sub> - h (km)	ΔV (m/s)	h <sub>s</sub> * (km)	Qdot (W/cr)
2	135	2	<b>12.9</b>	<b>0.52</b>	<b>3.0</b>	0.011
3	<b>122.1</b>	<b>11.6</b>	<b>7.6</b>	<b>0.30</b>	<b>3.0</b>	<b>0.06</b>
4	<b>114.5</b>	<b>32.5</b>	<b>4.5</b>	<b>0.18</b>	<b>3.0</b>	<b>0.18</b>
Post AB-4	110	60				0.33

# 135 km vs. 150 km AB-1 Target Altitudes.

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**Table 2: Aerobraking Maneuvers with Equal Values for  $h_s^*$**

AB-#	$H_o$ (km)	$\rho_o$ (kg/km <sup>3</sup> )	$h_o - h$ (km)	$\Delta V$ (m/s)	$h_s^*$ (km)	Qdot (W/cr)
2	135	2	<b>12.9</b>	<b>0.52</b>	<b>3.0</b>	0.011
3	<b>122.1</b>	<b>11.6</b>	<b>7.6</b>	<b>0.30</b>	<b>3.0</b>	<b>0.06</b>
4	<b>114.5</b>	<b>32.5</b>	<b>4.5</b>	<b>0.18</b>	<b>3.0</b>	<b>0.18</b>
Post AB-4	110	60				0.33

**Table 3: Aerobraking Maneuvers with Equal  $h_s^*$ , 150 km AB-1**

AB-#	$H_o$ (km)	$\rho_o$ (kg/km <sup>3</sup> )	$h_o - h$ (km)	$\Delta V$ (m/s)	$h_s^*$ (km)	Qdot (W)
2	<b>150</b>	<b>0.168</b>	<b>22.7</b>	<b>0.91</b>	<b>3.4</b>	<b>0.0009</b>
3	<b>127.3</b>	<b>4.72</b>	<b>11.5</b>	<b>0.46</b>	<b>3.4</b>	<b>0.026</b>
4	<b>115.8</b>	<b>25.6</b>	<b>5.8</b>	<b>0.23</b>	<b>3.4</b>	<b>0.14</b>
Post AB-4	110	60				0.33

# Different Atmosphere (10 km lower)

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**Table 3: Aerobraking Maneuvers with Equal  $h_s^*$ , 150 km AB-1**

AB-#	$H_o$ (km)	$\rho_o$ (kg/km <sup>3</sup> )	$h_o - h$ (km)	$\Delta V$ (m/s)	$h_s^*$ (km)	Qdot (W)
2	<b>150</b>	<b>0.168</b>	<b>22.7</b>	<b>0.91</b>	<b>3.4</b>	<b>0.0009</b>
3	<b>127.3</b>	<b>4.72</b>	<b>11.5</b>	<b>0.46</b>	<b>3.4</b>	<b>0.026</b>
4	<b>115.8</b>	<b>25.6</b>	<b>5.8</b>	<b>0.23</b>	<b>3.4</b>	<b>0.14</b>
Post AB-4	110	60				0.33

**Table 4: Aerobraking Maneuvers, Equal  $h_s^*$ , 150 km AB-1,  $H_s = 6.0$  km**

AB-#	$H_o$ (km)	$\rho_o$ (kg/km <sup>3</sup> )	$h_o - h$ (km)	$\Delta V$ (m/s)	$h_s^*$ (km)	Qdot (W)
2	<b>150</b>	<b>0.038</b>	<b>29.5</b>	<b>1.18</b>	<b>3.6</b>	<b>0.0002</b>
3	<b>120.5</b>	<b>2.93</b>	<b>13.9</b>	<b>0.56</b>	<b>3.6</b>	<b>0.016</b>
4	<b>106.6</b>	<b>22.7</b>	<b>6.6</b>	<b>0.26</b>	<b>3.6</b>	<b>0.12</b>
Post AB-4	<b>100</b>	60				0.33

# Planned Maneuvers, Unplanned Atmosphere.

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**Table 3: Aerobraking Maneuvers with Equal  $h_s^*$ , 150 km AB-1**

AB-#	$H_o$ (km)	$\rho_o$ (kg/km <sup>3</sup> )	$h_o - h$ (km)	$\Delta V$ (m/s)	$h_s^*$ (km)	Qdot (W)
2	<b>150</b>	<b>0.168</b>	<b>22.7</b>	<b>0.91</b>	<b>3.4</b>	<b>0.0009</b>
3	<b>127.3</b>	<b>4.72</b>	<b>11.5</b>	<b>0.46</b>	<b>3.4</b>	<b>0.026</b>
4	<b>115.8</b>	<b>25.6</b>	<b>5.8</b>	<b>0.23</b>	<b>3.4</b>	<b>0.14</b>
Post AB-4	110	60				0.33

**Table 5: Aerobraking Maneuvers, Equal  $h_s^*$ , 150 km AB-1,  $H_s = 6.0$  km**

AB-#	$H_o$ (km)	$\rho_o$ (kg/km <sup>3</sup> )	$h_o - h$ (km)	$\Delta V$ (m/s)	$h_s^*$ (km)	Qdot (W/cr)
2	<b>150</b>	<b>0.038</b>	22.7	0.91	<b>2.8</b>	<b>0.0002</b>
3	<b>127.3</b>	<b>1.08</b>	11.5	0.46	<b>2.4</b>	<b>0.006</b>
4 (to 100 km)	<b>115.8</b>	<b>5.85</b>	<b>15.8</b>	<b>0.63</b>	<b>4.9</b>	<b>0.032</b>
4 (= 3 )	<b>115.8</b>	<b>5.85</b>	<b>11.5</b>	<b>0.46</b>	<b>3.6</b>	<b>0.032</b>
<b>5 (ADDED)</b>	<b>104.3</b>	<b>31.8</b>	<b>4.3</b>	<b>0.17</b>	<b>2.9</b>	<b>0.17</b>
Post AB-4	<b>100</b>	60				0.33

# Additional Walkin Maneuver (AB-5).

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**Table 3: Aerobraking Maneuvers with Equal  $h_s^*$ , 150 km AB-1**

AB-#	H <sub>o</sub> (km)	ρ <sub>o</sub> (kg/km <sup>3</sup> )	h <sub>o</sub> - h (km)	ΔV (m/s)	h <sub>s</sub> * (km)	Qdot (W)
2	<b>150</b>	<b>0.168</b>	<b>22.7</b>	<b>0.91</b>	<b>3.4</b>	<b>0.0009</b>
3	<b>127.3</b>	<b>4.72</b>	<b>11.5</b>	<b>0.46</b>	<b>3.4</b>	<b>0.026</b>
4	<b>115.8</b>	<b>25.6</b>	<b>5.8</b>	<b>0.23</b>	<b>3.4</b>	<b>0.14</b>
Post AB-4	110	60				0.33

**Table 6: FOUR Aerobraking Maneuvers with Equal  $h_s^*$ , 150 km AB-1**

AB-#	H <sub>o</sub> (km)	ρ <sub>o</sub> (kg/km <sup>3</sup> )	h <sub>o</sub> - h (km)	ΔV (m/s)	h <sub>s</sub> * (km)	Qdot (W/cm)
2	<b>150</b>	<b>0.168</b>	<b>18.4</b>	<b>0.74</b>	<b>2.7</b>	<b>0.0009</b>
3	<b>131.6</b>	<b>2.51</b>	<b>11.0</b>	<b>0.44</b>	<b>2.7</b>	<b>0.013</b>
4	<b>120.6</b>	<b>12.6</b>	<b>6.6</b>	<b>0.26</b>	<b>2.7</b>	<b>0.070</b>
<b>5</b>	<b>114.0</b>	<b>33.3</b>	<b>4.0</b>	<b>0.16</b>	<b>2.8</b>	<b>0.18</b>
Post AB-5	110	60				0.33

# Candidate Maneuver Sizes for 150 km AB-1

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**Table 7: Candidate Maneuver Sizes for 150 km AB-1 Target Altitude.**

$\Delta V$ (m/s)	$\Delta h$ (km)	Comments
1.00	25	Large. $\approx$ Average AB-2, Tables 3 & 4
0.75	19	AB-2, Table 6 (Plan for extra “AB-5”)
0.45	11	AB-3, Tables 3 & 6
0.25	6	AB-4, Tables 3 & 6
0.15	4	AB-5, Tables 5 & 6. (Largest “Main Phase” ?)

# CONCLUSIONS

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- Targeting AB-1 for 150 km
  - increases the average critical scale height from 3.0 to 3.4 km,
  - still much less than the smallest realistic scale height of about 6.0 km.
  - 150 km Looks OK.
- If the density less than expected then critical scale height is increased
  - Critical Scale Height increased from 3.4 to 3.6 km as shown in Table 4 where the atmosphere is 10 km below that in Table 3
  - assuming that the maneuvers can be redesigned.
- Limited number of precanned maneuvers
  - an additional maneuver may be necessary.
- AB-1, AB-2 and AB-3 on consecutive orbits is highly desirable.